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DOCUMENT-IDENTIFIER: US 6181992 B1

TITLE: Automotive diagnostic service tool with hand held tool
and master controller

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US-CL-ISSUED: 701/29, 701/35

US-CL-CURRENT: 701/29, **701/35**

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ART-UNIT: 361

PRIMARY-EXAMINER: Nguyen; Tan

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ABSTRACT:

The present invention relates to a system and method for diagnosing and
isolating problems and for monitoring operting conditions on an automobile.
The system includes a hand held unit and a master station which can operate
alone or in unison to accomplish functions such as logging and displaying data
on a real-time basis, logging data remotely and displaying the data at a later
time, diagnosing fault conditions, monitoring operating parameters,
reprogramming on-board vehicle controllers, displaying service manual and
service bulletin pages and ordering parts on-line.

17 Claims, 18 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 14

---------- KWIC ---------

Application Filing Date - AD (1):
**19950428**

Detailed Description Text - DETX (6):
The vehicle interface capabilities of the hand held unit will now be
described in greater detail. The vehicle interface connector 42 is a
thirty-six way connector. The hand held unit 10 is interfaced to the vehicle
12 via the vehicle interface cable 16. In this embodiment, the vehicle
interface 44 is adapted to work with a variety of interface cables.
Specifically, six different types of cables are currently supported. All of
these cables, while utilizing the same thirty-six way interface, support
different communication protocols. For example, an ISO 9141/CARB cable is an

asynchronous full duplex serial **communication link configurable to a variety of baud** rates, such as 976, 7812.5, 62.5K, and 10.4K **baud** rates, with signal levels varying between an idle condition of twelve volts and zero volts. Similarly, an SCI-I cable is an asynchronous duplex serial **communication link configurable to baud** rates such as 976, 7812.5, and 62.5K **baud,** with the signal levels varying from an idle of zero volts to five volts. Both the SCI-I and ISO 9141/CARB communication links utilize the standard ten bit non return to zero (NRZ) data format, with one start bit, eight data bits and one stop bit. Yet another cable communicates using a contention-based, class B multiplexed bus, **transferring data at 7812.5 baud** via a voltage differential generated across the bus which is biased to 2.5 volts.

Detailed Description Text - DETX (8):

The actual architecture of the hand held unit's controller can be found in FIG. 4. As shown here, there are two microcomputers on board, an ST9 50 and an MC68332 (not shown). The ST9 microcomputer, commercially available from S. G. Thomson of Texas, is the communications coprocessor while the MC68332 microcontroller, available from Motorola of Illinois, performs the diagnostic and data gathering features. The ST9 controller has A-D converters 52 for measuring and scaling information from the vehicle interface connector, and has addressing and data control buffers 54-60 for communicating with the MC68332 controller. Likewise, the MC68332 has interface buffers and A-D converters. Here, both regular speed and high speed A-D converters are used to ensure the data gathering process is rapid and accurate. On board, the hand held unit has 4.5 megabytes of memory. One 250K block of memory is the boot **ROM,** which can

be **reprogrammed, or "flashed"**, to alter the operation of the hand held unit.
The boot memory contains the operating system and device drivers used by the
band held unit. Another 250K block of memory is pseudo-static memory with a
ninety-six hour **storage** life. This memory is used for **storing** specialized
diagnostic routines that have been downloaded to the hand held unit, and for
**storing** customized data gathering templates. Another 1 Mb block of memory is
also flashable, and **stores** the diagnostic procedure information. This memory
can be reflashed via the master station link 18 from the master station 14 or
can be reflashed using a memory expansion card in one of the expansion slots
31, 48 or via the RS232 serial link 40. Another 1 Mb block of memory is pseudo
static memory with an eight hour life. This memory, like the ninety six hour
life memory, is used to **store** information such as specialized diagnostic
routines. The final 2 Mb block of memory is RAM.

Detailed Description Text - DETX (22):
The hand held unit is also capable of downloading information to the vehicle
controllers for the purpose of updating these controllers. For example, most
controllers utilize a combination of **ROM** and RAM. The **ROM** contains the control
algorithm and calibration parameters, while the RAM contains operational
parameters. When controllers were first being used on automobiles, the **ROM** was
hard coded, that is, the **ROM** was fixed and unchangeable. Likewise, RAM was
volatile and any information **stored** in RAM would be lost if the controller
power supply was interrupted. Today, automotive controllers rely upon a
combination of hard coded and erasable **ROM** in addition to RAM. The erasable
**ROM** usually contains information such as calibration

parameters. Frequently, after a vehicle has been introduced into production, knowledge learned after use of the vehicle by customers in the field will necessitate a change in calibration parameters. Rather than requiring the entire controller to be removed and replaced or the memory chips to be removed and replaced, **storing** calibration parameters in erasable **ROM** allows the calibration parameters to be **rewritten**. Here, the hand held unit has the capability to **write, or "flash"**, erasable memory on the vehicle controllers. To accomplish this, the hand held unit has, **stored** in its own internal memory, the new information to be downloaded to the vehicle controller. The technician enters the **flash programming** mode by selecting the appropriate menu item from the display screen. Once this mode is selected, the hand held unit sends a control message to the controller to inquire as to the version and model number of the controller's memory. Upon receiving the response from the vehicle controller, the hand held unit determines whether or not the vehicle controller's memory needs to be updated. If the memory does need to be updated, the technician is presented with a screen indicating so and asking the technician whether or not he wishes to proceed. Assuming the technician has indicated his desire to proceed by pressing the yes key, the hand held unit sends the commands to the vehicle controller necessary to reconfigure the programmable **ROM** to reflect the new calibration values. The process of sending the appropriate commands and calibration data to a vehicle controller and verifying that the information has been correctly received and **stored** is well within the grasp of one of ordinary skill in the art, and therefore will not be described in detail herein. Once

the commanding, **writing** and verification process has been completed, the hand
held unit displays to the technician whether or not the vehicle controller
update procedure has been successful.

Detailed Description Text - DETX (40):

The master station 14 is designed to work in cooperation with the hand held
unit in performing sophisticated diagnostic procedures and the like, and can
operate independently of the hand held unit as a reference resource for the
service technician. The master station itself is approximately 41/4 feet tall,
with a base dimension of approximately 36 inches by 24 inches. The heart of
the master station is an IBM-compatible computer with an internal hard drive.
The master station also includes a 19 inch monochrome video monitor 100 for
graphics display, a keyboard 102, a floppy disk drive and CD-**ROM** drives 104,
and communication cables 18. The master station cart 106 has casters 108 at
the base for allowing the station to be rolled from place to place. The
internal memory of the computer contains the master station operating system,
while the CD-**ROM** drives are used to **store** service and diagnostic information
and the like. The floppy disk drive accepts standard 31/2 inch disks and is
used for things such as swapping information between stations and for
performing backups and **storing** seldom used information, while the larger
capacity hard drive is used for **storing** information such as diagnostic results
and customized test procedures. The master station can operate alone or in
conjunction with the hand held unit 10. Specifically, regardless of whether
the master station 14 is connected to the hand held unit, the master station is
capable of operating as a technical information library, parts catalog and host

update link. However, when connected to the hand held unit, the master station
is also capable of acting as a data recorder, diagnostic station, and hand held
unit update host. The master station, besides having a GPIB interface for
communicating with the hand held unit, also has an RS-232 interface for
communicating with other service tools. In this embodiment, earlier generation
hand held units communicated only via RS-232. Therefore, the master station of
the present invention can communicate with older units via the RS-232 while
also communicating with the hand held unit via the GPIB link.

Detailed Description Text - DETX (43):

The master station obviates the need for printed paper manuals and service
bulletins through its technical information library mode. In this mode, the
technician can access service manuals and service bulletins, which are **stored**
on the CD-**ROM's**, for display on the monitor. This mode has several benefits.
First is the advantage of obviating the need for paper manuals and service
bulletins, which often become torn, soiled and lost over time. Also, because
the information is **stored** electronically and retrieved only as needed, there is
no need to have book shelves for **storing** these items. Moreover, as information
changes and requires updates, new "pages" can be added electronically by
updating the CD-**ROM** without requiring the technician to physically insert pages
into a printed manual. Updating technical information can also be accomplished
by supplementing the information on the CD-**ROM's** through information **stored** on
floppy disks, as well as information available via telecommunication download
links, such as modems. In this embodiment, the master station can be connected
to any conventional phone line for communicating with a

remote host computer
for downloading update information. Once the information is downloaded into
the master station, the updated information can be **stored** in the internal
memory of the master station or on a floppy disk. By allowing updated
information to be provided via these different methods, the master station
technical information library can be easily maintained in an up to date state.

Detailed Description Text - DETX (62):
After having proceeded through the fault diagnosis procedure without yet
locating the problem, the technician turns to the master station to access the
technician information library for more assistance. Using the keyboard on the
master station, the technician enters the vehicle type and model year to see if
a service bulletin has been issued regarding this problem. The master station
searches its CD-**ROM** data base for a relevant bulletin and presents the
information to the technician on the monitor. In this example, the bulletin
informs the technician that problems such as this have indeed been experienced
in the field, and a new diagnostic procedure has been provided. Upon learning
this, the technician connects the hand held unit to the master station via the
communication link and, using the keyboard, request the master station to
download the new diagnostic procedure to the hand held unit. The master
station relays the information to the hand held unit, and the new diagnostic
procedure is **stored** in the hand held unit's eight hour memory. The technician
then begins executing the new diagnostic procedure.

Detailed Description Text - DETX (66):
Having successfully diagnose the problem, the technician then updates the

engine computer to erase the fuel error air fault flag and enter the service information. He reconnects the hand held unit to the vehicle, and clears the codes. Next, as shown in FIG. 17, he enters his ID number, the VIN number, the service order number and the mileage in hand held unit and **flash programs** the information into the engine controller's service log memory. Before letting the car be released to the customer, the technician checks to see if there are any service bulletins indicating an interim calibration update has been released. Checking the technical library, he learns that there has been a new set of anti-lock calibrations released. The technician places a memory module with the new calibrations into the expansion slot of the hand held unit. As shown in FIG. 18, the technician can load update calibrations into the hand held unit using a memory card or the master station. Next, the technician queries the car's antilock controller to see if it has the latest set of calibrations. The controller responds that it currently it running "version 3.01b" calibrations. The hand held unit indicates to the technician that there are newer calibrations in the memory card, and asks him if he would like to proceed with downloading these new calibrations to the anti-lock controller. He responds "yes", and the hand held tool **programs** the anti-lock controller's **flash** memory with the new calibrations. The controller sends a message to the hand held tool, which is displayed for the technician, indicating the update was successful.

Related Application Filing Date - RLFD (1):
**19930625**

Current US Cross Reference Classification - CCXR (1):